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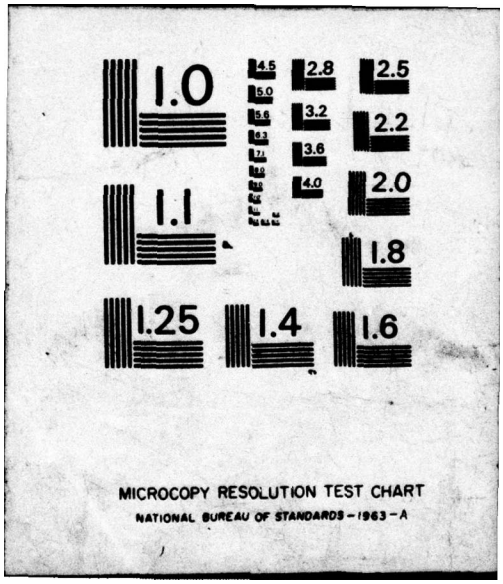
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Interim Report

TRAINING EFFECTIVENESS OF XM35 CONDUCT OF FIRE TRAINER (COFT)

by

D. F. Haggard
LTC W. Q. Harty

March 1967

This Interim Report has been prepared to provide preliminary information on the results of a research effort. It does not necessarily represent official opinion or policy of either the Human Resources Research Office or the Department of the Army.

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The purpose of this study was to field test the training effectivness of the product of the original SDR which is designated the XM35 Conduct of Fire Trainer (COFT). The present study design permits evaluation of the COFT with visual missile representation including target miss-distance indicator information, but without the print-out of in-flight tracking performance as feedback to the gunner and the instructor.

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INTERIM REPORT OF TRAINING EFFECTIVENESS OF XM35, CONDUCT OF FIRE TRAINER (COFT)

A. BACKGROUND

With the proposal of the Shillelagh Weapons System, the US Army Armor School, in 1960, stated a requirement for a trainer which would allow the training of gunners on missile firing skills. In planning for training effectiveness, the military characteristics (written in 1961) outlined that a device be developed which would present a realistic visual representation of the missile so that the gunner might learn to respond to what he saw and that the device provide performance feedback which might be used in critiquing the gunner by his instructor. During later planning conferences, it was suggested that the device be so engineered that the various types of input to the student could be evaluated, in terms of training effectiveness, separately. The purpose of this study was to field test the training effectiveness of the product of the original SDR which is designated the XM35 Conduct of Fire Trainer (COFT). The present study design permits evaluation of the COFT with all components operating and of the COFT with visual missile representation including target miss-distance indicator information, but without the print-out of in-flight tracking performance as feedback to the gunner and the instructor. Students trained on either the full COFT system or the modified system were to be compared as missile gunners with students trained on the M551 vehicle without benefit of a training device.

The military characteristics for the Shillelagh Weapon System had indicated that the relatively high costs of the missile would preclude actual missile firings for

training purposes. Thus a missile simulator was requested as a means of providing gunnery training with the missile system. The simulator was to be mounted on the M-551 and on subsequent vehicles designed to accept the Shillelagh Missile System. The purpose of the device was to provide missile firing experience during AIT, Armor training and later Unit proficiency maintenance training without requiring the expenditure of actual missiles.

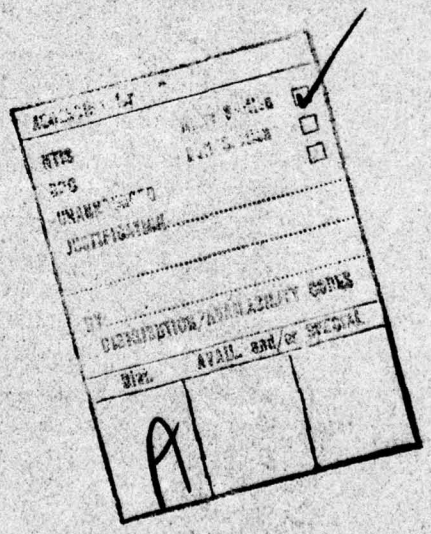
Service testing of the prototype and preproduction models of the device, by the US Army Armor and Engineer Board, indicated a relatively large number of durability and reliability deficiencies. The extent of these deficiencies precluded a test of training effectiveness before further device modification. USCONARC, USAARENBD, and CDC therefore recommended a delay in commitments for device procurement until the major deficiencies had been corrected and device testing could be completed.

In acting on this recommendation, DA held a conference at Fort Knox on 5 Jan '67 with representatives attending from DA staff, USCONARC, USACDCARMA, USAARENBD, USAARMS, HumRRO, USNTDC, and the Project Manager's Office/M551. The conference indicated that the device, in its present configuration, contained a number of deficiencies and shortcomings that could, and would, be corrected by the manufacturer. Additional testing of the modified device's reliability, durability and training effectiveness would be required before a valid recommendation concerning acceptance or rejection could be made. Based on this information, DA deferred an AMC request for an extension of a limited production (LP) type classification until a thorough evaluation could be completed. Such an evaluation was to include a retest of the deficiencies

isolated on the earlier models and a determination of the training and cost effectiveness of the device. All testing was to be completed by 15 Mar '67.

Subsequent to the conference, an AMC agreement extended the limited production contract for procurement of the COFT. However, this agreement stipulated that the contract could be terminated if the further testing indicated that the device was unacceptable.

To accomplish the test of training effectiveness, a series of meetings was held between representatives of HumRRO, USAARENBD, USAARMS, USACDCARMA, USATCA, and The Armor Center G3. During these meetings, a basic plan of test outlined by HumRRO was accepted and responsibilities and schedules for conduct of the test were established. Appendix A presents the basic plan, responsibilities, and schedule.



B. The Conduct of Fire Trainer XM35 (to be included by USAARMS).

C. METHOD

1. Subjects. Enlisted men from USATCA and from the 16th Armored Group served as trainees. It was required that they had "recently" graduated from AIT, Armor with gunner qualification scores on Tables IV and V. "Recently" was defined as "within the past three months" but this latter definition was not strictly adhered to.

A pool of 44 enlisted men were assigned for Replication I of the study. From this pool, three training condition groups of 10 trainees were selected. The groups were matched on GT, gunnery qualification score, and time scores on the Marrietta Apparatus Company Two-Arm Tracing Apparatus. (In addition, the groups were balanced on Armed Forces Vision Tester scores for uncorrected far and near visual acuity-preferred eye, far and near visual acuity-nonpreferred eye, far and near vertical phoria, and far and near lateral phoria.) Due to delays in the study, 8 replacements were later assigned to the groups. Later trainee losses during the study reduced group numbers to 8, 9, and 10. The average scores on the three matching measures for these trainees are given in Table 1.

Table 1
Average Scores on Group Matching Measures

Replication I	N	GT	Gunnery Qualification	Two-Arm Tracing
Training Condition I	8	96.4	185.6	171.1
Training Condition II	9	98.1	181.7	157.9
Training Condition III	10	109.1	186.3	152.3
Replication II				
Training Condition I	9	95.8	186.1	128.2
Training Condition II	8	103.1	185.6	122.2
Training Condition III	8	97.2	185.5	128.9

A pool of 40 enlisted men were assigned for Replication II of the study. From this pool, three training condition groups of 12 trainees were selected. These groups were matched as in Phase I. Later trainee losses during the study reduced group numbers to 9, 8, and 8. The average scores on the three matching measures for these trainees are given in Table 1.

During the course of the study, reductions in the original numbers of trainees assigned to the groups were due to trainee re-assignment to other Units or to OCS or, in one case, AWOL. No trainees were omitted from the study on the basis of conduct or performance in the study.

2. Conduct of Training. Three XM35 Conduct of Fire Trainers (COFT) mounted on M551 vehicles and one XM35 target device mounted on an M551 vehicle were used. For each of the two replications of the study, each of the three groups of trainees was assigned to a training condition as follows:

a. Condition I (No COFT). The COFT was not energized during any of the training periods. Instructor critique of gunner performance was based mainly on his judgment of gunner performance. The instructor used the vane sight and the azimuth indicator for determining azimuth errors, but had no indication of elevation errors.

b. Condition II (COFT minus chart recorder). During training, all COFT assemblies excepting the chart recorder were energized. Instructor critique was based on judgment, aided by the vane sight, azimuth indicator, and miss-distance indicator.

c. Condition III (COFT). During training all COFT assemblies were energized. Instructor critique was based on information from the miss-distance indicator and the chart recorder which was kept in the AUTO mode.

All training was conducted by The Armor School, as shown in Table 2. Training was to be conducted over 8 days[1] as follows:

[1]The original plan, APPENDIX A, specified 10 training days. This was reduced due to scheduling difficulties.

TABLE 2
CONDUCT OF FIRE TRAINER PROGRAM

DAY	PURPOSE	TARGET DISTANCE (METERS)	REPLICATION 1 DATE	REPLICATION 1 LAUNCHERS	REPLICATION 1 REMARKS	REPLICATION 2 DATE	REPLICATION 2 LAUNCHERS	REPLICATION 2 REMARKS
1	Gunner Station Familiarization Trainee Pre-Test and Assignment		31 Jan 13 Feb		Replacements For Loss During Study Delay	20 Feb 21 Feb		Too Few Trainees Reported. Additional Trainees For Groups
2	Control Manipulation Practice (15 Min. Per Trainee in AM) (15 Min. Per Trainee in PM)	900-1500	1 Feb 13 Feb	3	For Replacements	23 Feb 25 Feb	1 2	1 Day Delay Due to Legal Holiday 1 Day Delay Due to Icy Roads
3	Experimental Training (15 Min. Per Trainee in AM) (15 Min. Per Trainee in PM)	900-1200	3 Feb 13 Feb	3	1 Day Delay Due to Heavy Rain For Replacements	27 Feb	2	
4	Repeat Day 3 Training	900-1200	13 Feb 14 Feb	3	9 Day Delay Due to Priority Equipment Needs For Replacements	28 Feb	2	
5	Repeat Day 3 Training	1200-1800	14 Feb	3		1 Mar	2	
6	Repeat Day 3 Training	1000-1800	15 Feb	2		2 Mar	2	
7	Repeat Day 3 Training	1000-1200	17 Feb	2	1 Day Delay Due to Equipment Failure	3 Mar	2	
8	Repeat Day 3 Training	900-1000	18 Feb	2		4 Mar	2	

Day 1. The trainee pool was divided into two equal groups. During the morning one group reported to The Armor School for orientation and turret familiarization training. The second group reported to the US Army Human Research Unit for pretesting. During the afternoon the groups were reversed.

The initial orientation, conducted by The Armor School, was aimed primarily toward an explanation of the test and an introduction to the Armored Reconnaissance/ Airborne Assault Vehicle M551. During this orientation, emphasis was placed upon all participants knowing the "name of the game" and acquiring an appreciation of the conduct of the test. General characteristics, capabilities and limitations of the vehicle were explained; the ammunition peculiar to the gun/launcher system was introduced, and safety measures were stressed. At the conclusion of this training, an orientation film provided by the Sheridan Project Manager's Office (Film Release Number 12) was shown to the group.

Following the film, an abbreviated turret familiarization class was conducted. All controls and locations of major components were pointed out and their function explained. Detailed operation of the breech, recoil systems and "G and C" components were eliminated. Only those controls necessary to successfully track a moving target were stressed. In the interest of economy of time and accuracy, all zeroing, alignment and systems checks were completed by NCO instructors. Emphasis was placed upon the gunner's control handle, trim controls, diopter setting, filter and reticle light intensity control.

After all pretesting and orientation had been completed, HumRRO selected the men to be trained and assigned them to the three training conditions. Selection was

based on the requirements for matching the three groups on the basis of the General Technical score on the ACB, gunnery qualification during AIT, Armor; the Marrietta Two-Arm Tracer; and the Armed Forces Vision Tester.

Day 2. All trainees received a review of the gunnery controls and preparatory training in control manipulation and sighting. The preparatory training consisted of two 15-minute periods of tracking a moving target; one period in the morning and one period in the afternoon. The target vehicle used was an M551 vehicle similar to that used as a target during the balance of the test program. Range to the target and speed of the target were varied during this phase of training. Introduction of the fire command to engage a target with a missile was introduced at this time. Accuracy of lay, and smoothness of track were monitored by the NCO instructor by use of the vane sight and the azimuth indicator.

Days 3 - 8. During this period each trainee received three hours of tracking and firing practice under the experimental conditions. Training was conducted on the basis of 1/2 hour of practice per trainee per day: 15 minutes in the morning and 15 minutes in the afternoon. To obtain equal target, weather and lighting influences between groups, the three M551 launcher vehicles were parked side-by-side with one trainee for each condition practicing concurrently.

The target vehicle traversed a "cross-country" tank path perpendicular to the line of sight of the launcher vehicles. The target course was right-to-left and left-to-right at an average speed of 15mph. No evasive action could be undertaken.

During practice the instructor-vehicle commander issued the fire commands

and critiqued the trainee after each firing based on the data provided by the condition instrumentation.

As shown in Table 2, numerous factors modified the planned conduct of training. The major modification was due to a priority need for the launcher vehicles. This resulted in a nine-day delay between the third and fourth training days of Replication I. During the delay eight trainees were reassigned. Their replacements were trained under a compressed schedule for Days 1 - 5. Six replacements completed the study: three in Condition II and three in Condition III.

A second modification of the plan was due to range facilities. It had been planned to run tracking trials consisting of a series of three consecutive target distances: long, medium, and short. Target facilities restricted target vehicle runs to one course with a minimum and maximum distance specified by the point directly in front of the launcher vehicles and at the end of the course respectively. Range availability forced target distances to vary over training days with a preponderance of short-medium distances.

A third factor was weather and equipment failures that caused a few one-day delays in the schedule. In addition, equipment malfunctions in both vehicle and trainer, limited available launcher vehicles to two during the final part of Replication I and all of Replication II. Malfunctions occurring during a training day are not noted in Table 2, but were frequent during Replication I and were evident on one day during Replication II. In all cases, training was conducted, or continued, for the affected conditions, by training the groups in sequence.

3. Trainer Tests. At the conclusion of each day's training, each trainee received four firing runs which were recorded on the chart recorder. All other trainer instrumentation was kept consistent with the training conditions. A HumRRO assistant monitored the records for Conditions I and II so that the instructor did not see the chart and, therefore, would not be tempted to provide unplanned feedback.

Training for both replications was concluded on a Saturday. On the following Monday, all available trainees who were not selected to fire the missile returned to the range. Each trainee received one dry-run trial for control familiarization and two recorded simulated firings with full missile simulation. These trials constituted a non-firing performance proficiency test.

For all COFT records a hit-miss analysis was made based on the missile flight path to a 7.5 x 7.5 foot target. In addition, the maximum allowable DOWN error from the center of the target was set at 2.5 feet. Missile error greater than this in the DOWN direction might result in grounding. Thus the hit criteria required no more than 3.75 feet LEFT, RIGHT, or UP error at time of missile impact on the target and no more than 2.5 feet DOWN error at any time during the missile flight.

4. Missile Firings. At the conclusion of training, the "best" three trainees in each training condition were selected by HumRRO on the basis of the daily COFT test records. Each trainee fired two missiles; the first at a long range target and the second at a medium range target.

All targets were 7.5 x 7.5 foot panels traveling a straight, level course perpendicular to the line-of-sight of the launcher vehicle. Average target speed was

15 mph. Before each firing the trainee received two target runs, each right-to-left and then left-to-right, for control familiarization. The trainee then fired the missile during the next right-to-left run.

Firings were to be conducted during three consecutive days following the completion of training for each replication. During each day, one trainee from each training condition was to fire with the following order of conditions within days:

Replication I -- 1, 2, 3 -- 2, 3, 1 -- 3, 1, 2

Replication II -- 3, 2, 1 -- 2, 1, 3 -- 1, 3, 2

Because of severe weather conditions, the firing days were changed as shown in Table 3. However, the planned order of firings was maintained.

Table 3. Missile Firing Dates

Training Condition	Long Range	Medium Range
I	20 Feb	27 Feb
II	22 Feb	27 Feb
III	22 Feb	27 Feb
II	23 Feb	27 Feb
III	23 Feb	27 Feb
I	23 Feb	27 Feb
III	3 Mar	3 Mar
I	3 Mar	3 Mar
II	3 Mar	3 Mar
III	7 Mar	7 Mar
II	7 Mar	7 Mar
I	7 Mar	7 Mar
II	8 Mar*	8 Mar
I	8 Mar*	8 Mar
III	8 Mar*	8 Mar
I	8 Mar	8 Mar
III	8 Mar	8 Mar
II	8 Mar	8 Mar

*These firings were omitted from the analyses due to one known and two suspected missile system failures.

Again, hit-miss data were used as the performance criteria. This data was provided by spotters and surveys of the target panel.

During Replication II, a series of three long range firings was degraded by one known and two suspected missile system failures. This series, one missile from each training condition, was omitted from the analysis.

D. RESULTS AND DISCUSSION

1. Missile Firings. The primary criteria for comparison of the training conditions was hit-miss data during the actual missile firings. Figure 1 shows the average proficiency levels for the six missile firers in each condition during training. Since the training test conditions varied (i.e., no missile simulation during training for Condition I), no direct comparison can be made between groups. However, it can be noted that all groups seem to have reached a high level of proficiency by the completion of training.

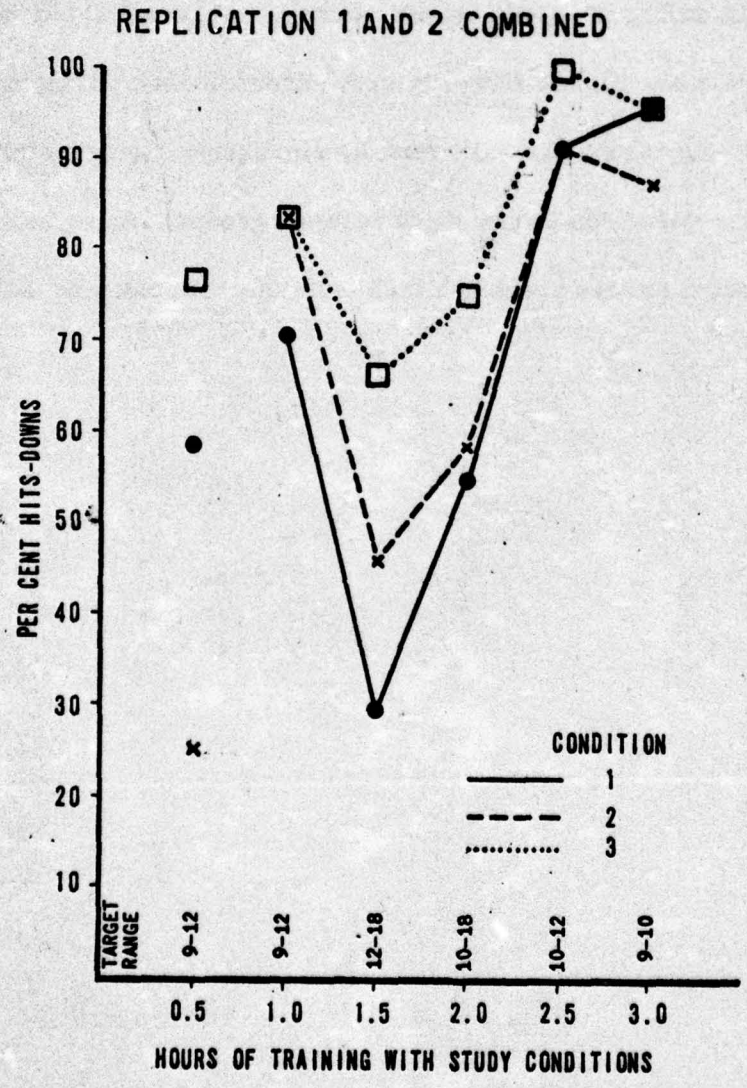


FIG 1. MISSILE FIRERS HIT-MISS AVERAGES DURING TRAINING

The total number of target hits for each training condition at each target range is shown in Table 4. For comparison over training conditions and ranges, the data have also been converted to percentages. The percentages indicate that the Condition III (COFT) trainees performed at a relatively high level at both target ranges. But the performance of the Condition I (No COFT) and Condition II (COFT minus recorder) trainees tended to be poorer at the longer range. Over-all the Condition III trainees performed best, Condition I next best, and Condition II poorest.

Table 4

Target Hits During Missile Firings

	Long Range (N = 5)*	Mid Range (N = 6)	
Number of Hits			Total (N = 11)
Condition I	2	4	6
Condition II	0	3	3
Condition III	4	5	9
Percentage of Hits			Mean
Condition I	40	66	54
Condition II	0	50	27
Condition III	80	83	82

*Omitting one long-range firing from each Condition due to known and suspected missile system failures.

A statistical test of the differences (Cochran Q test; Siegel, 1956) was calculated separately for the long-range and medium-range firings.[2] The difference between Condition III and Condition II for long-range firings was reliable. No other differences between the groups were reliable. It would appear then that missile simulation with the chart recorder provided some aspect of training that transferred to the actual missile firings; and that this aspect could not be obtained by simple tracking practice. What this aspect is cannot be definitely determined from the rather sparse data available. A review of the over-all results indicates that missile simulation may provide the experience in coping with obscuration and missile flare effects that is otherwise provided by the first actual missile firing. Also, that the permanent record during gunnery training may increase gunner proficiency in smooth tracking and the control of the missile that is required to a greater degree when firing at long-range targets.

2. End-Of-Training COFT Tests. A secondary criterion for comparing training conditions was provided by the two simulated firings after the completion of training. These test firings were conducted for all trainees who had not been selected to fire missiles (one trainee was lost due to reassignment immediately after the completion of training). On all firings there was complete simulation of missile effects. Unfortunately, all firings had to be conducted at a short range.

Figure 2 shows the average proficiency levels for the nonfirers in each condition during training and on the post-training tests. Again, no valid statistical comparison can be made between the groups but there seems to be only slight differences

[2]The .05 level of statistical reliability was established as acceptable for all analyses in this study.

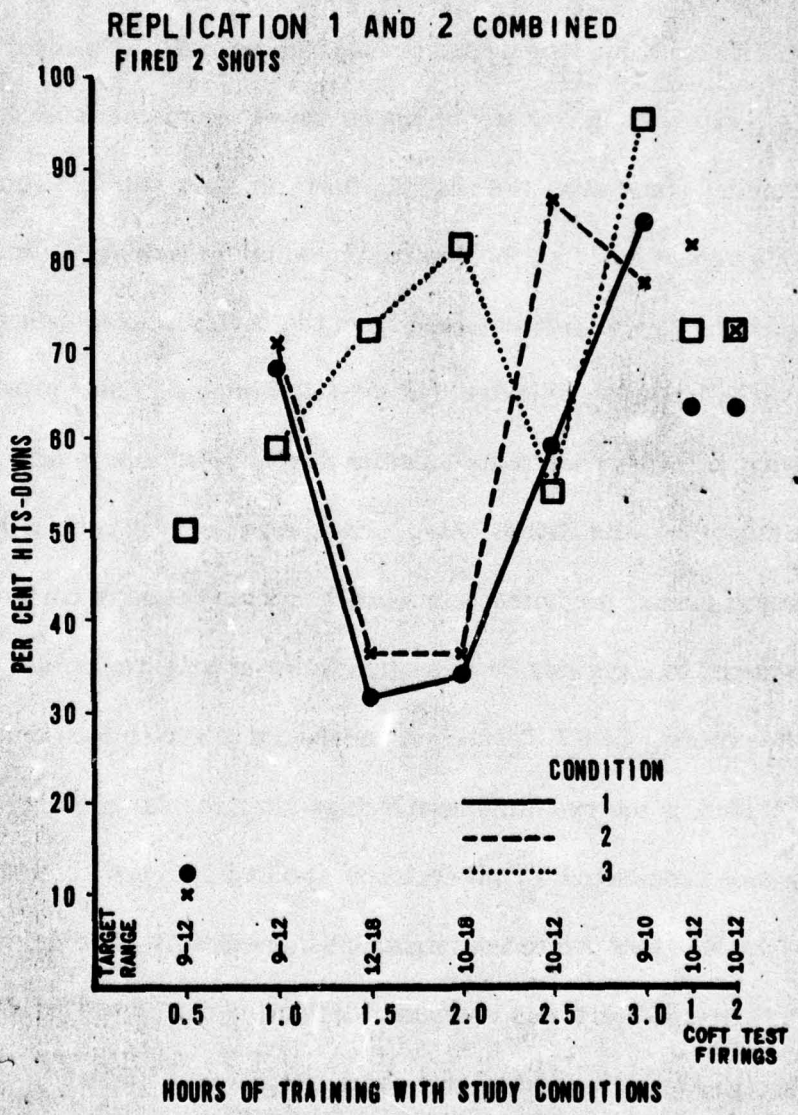


FIG 2. NON-FIRERS HIT-MISS AVERAGES DURING TRAINING AND POST-TRAINING COFT TEST.

at the completion of training.

All groups evidence some loss on the final test firings. This is probably due to the lack of sufficient warm-up practice: one target run before the final test firings as compared to 15 min. of practice before the daily tests. Statistical tests of the differences on each post-training firing (Cochran Q test; Siegel, 1956) indicated no significant differences between the training condition groups.

3. Summary of Post-Training Tests. Both the missile firings and simulated firings at short and medium range targets indicated that, when fairly high levels of tracking proficiency have been attained, there is little degradation in performance due to the introduction of obscuration and missile flare effects. This finding corresponds with earlier studies using more grossly simulated conditions (Haggard, 1966).

For the long-range missile firings (there were no long-range simulated firings), the results are not as clear cut. The rank-order of the groups is Condition III best, Condition I next, and Condition II poorest. In terms of hit percentage these differences appear large: 80, 40, and 0 per cent respectively. However, the statistical analysis of the number of hits was not significant with the exception of the extremes. In part, this may be due to the large difference that is required with such a small number of missiles. Extreme effects would be required and these effects might not be expected to be evidenced at the end of so extensive a training period. While no conclusive answer can be given it appears as though the COFT may provide a higher level of smooth tracking proficiency, and this difference is evidenced in better missile control after obscuration clears and, therefore, higher hit probability at the longer ranges. The present COFT study does not provide the data to check this assumption but some indication can be obtained from the recorded in-training tests discussed next.

4. In-Training COFT Tests. The data from the in-training tests provide some information pertinent to the post-firing results. The purpose of these tests was to provide learning curve information that would aid in planning training time for the method selected. Test trials were therefore run under the same conditions as training.

No direct comparison was intended between the curves since the firing conditions for Training Conditions II and III included obscuration and missile flare effects. These effects were thought to make the task more difficult than for Condition I. Thus, except for the effects of feedback provided by the missed distance indicator and/or the chart recorder, Conditions II and III were expected to perform at a lower level during training than would Condition I.

For each trainee the percent hits was calculated for the four firings administered at the completion of each day of training. The average for each group is by days (1/2 hour of training practice per day) in Figure 3. The curves are plotted separately by replication because no records were available for the first training day of Replication I[3] and the records for the second day (1 hr. of training practice) are extremely inconsistent for Conditions I and II between replications. The remainder of the curves are fairly consistent between replications.

[3]Records for this day were obtained but a malfunction in the target system resulted in out-of-range readings for most of the firings. Such a large number of firings could not be repeated due to the possibility of providing extensive training during a testing period.

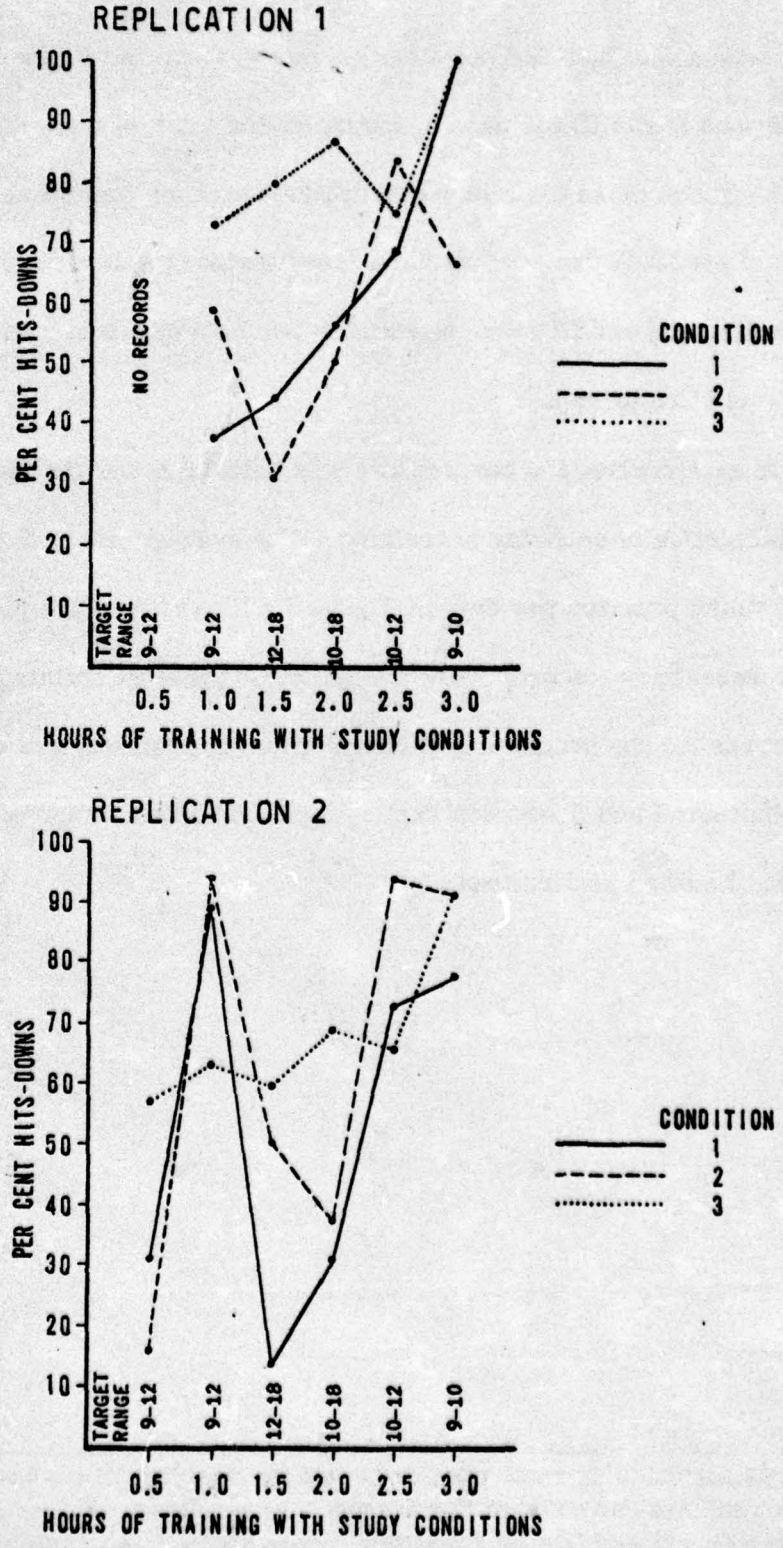


FIG 3. HIT-MISS AVERAGES DURING TRAINING

The curves in Fig. 3 indicate three major points. (1) Despite expectations, the miss distance indicator seemed to provide enough information for immediate gunner critique to overcome the presumed degrading effects of obscuration and missile flare. Further, the addition of the chart recorder added enough information to bring the trainees to an even higher level of proficiency in a shorter time period than either of the other two conditions. (2) All groups have reached a fairly high level of proficiency on the shorter range targets by the end of the three hours of training practice. (3) With practice on only short-range targets, Condition III trainees were able to demonstrate a fairly high level of proficiency on long-range targets. Conditions I and II trainees did not demonstrate high proficiency on long-range targets.

The statistical analysis (Lindquist Type I, 1953) of the differences (indicated in Figure 3) is summarized in Tables 5 and 6. As shown, there is a significant interaction between training days and training conditions. For this reason Newman-Keuls subanalyses (Winer, 1962) were computed for the differences within each condition and within each day for each replication.

Table 5

Summary Analysis of Variance of the Percent Hits for Replication 1 During Training

Source	df	Mean Square	F	p
Training Conditions	2	8885.88	18.13	$<.01$
Error Between Conditions	24	490.22		
Training Days	4	5724.54	10.69	$<.01$
Days x Conditions	8	1932.18	3.61	$<.01$
Error Within Conditions	96	535.36		
Total	134			

Table 6

Summary Analysis of Variance of the Percent Hits for Replication 2 During Training

Source	df	Mean Square	F	p
Training Conditions	2	3102.22	3.55	$<.05$
Error Between Conditions	22	874.04		
Training Days	5	13736.67	26.88	$<.01$
Days x Conditions	10	2635.28	5.16	$<.01$
Error Within Conditions	110	511.03		
Total	149			

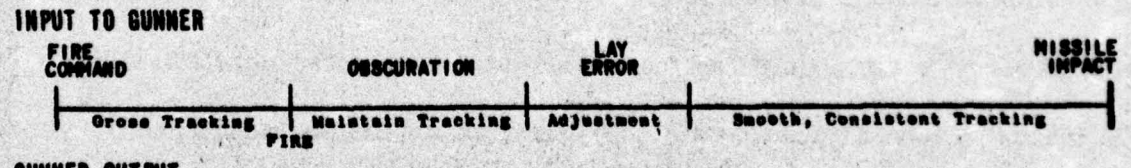
The results of these analyses are summarized in Tables 7 - 10 presented in Appendix B. These analyses support the three points noted above. (1) The trainees in Condition II do at least as well as those in Condition I and Condition III performs at a significantly higher level than either of the other two groups (Tables 9 and 10). (2) Condition III trainees attain a relatively high degree of proficiency during the first 1/2 hour of training while the other trainees need a greater amount of training to reach this level (Tables 7 - 10). (3) The trainees in Conditions I and II tend to show a significant drop in proficiency when transferred to long range targets while those in Condition III show little effect (Tables 7 and 8).

E. IMPLICATIONS

While each of the criterion measures (missile firings, post-training COFT tests, and in-training COFT tests) provides only partial information with respect to the problem; taken together, and considering previous related studies (e.g., Haggard 1966), there do seem to be some fairly clear implications for training:

1. Gunner proficiency required in missile firing at a moving target must be considered as a sequence of skills varying not only in type but also in the quality required. This sequence, shown in the following diagram, consists of (1) the relatively gross track that must be established before firing, (2) firing the weapon, (3) retaining the established tracking rate and direction during obscuration, (4) adjustment after obscuration to correct for target directional change

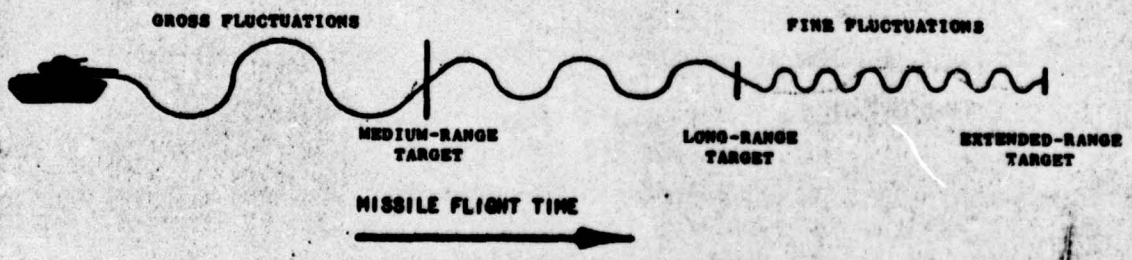
and accumulated error in the initial tracking rate, and, finally, (5) establishing a smooth and consistent rate until missile impact on target. From



this diagram we can define two tracking requirements. The first requirement is the establishment of an initial and generally consistent rate of tracking before firing and maintenance of this rate and gross degree of consistency during obscuration and until discrepancies between line-of-sight and target are noted. As soon as discrepancies are observed, the gunner must make an immediate adjustment and continue to track. With the relatively long periods of obscuration resulting from firing the Shillelagh missile and the one to two second reaction time required for relaying, this segment of the task would appear to encompass the requirements for engaging short range targets.

The second requirement occurs after the post-obscuration adjustment or re-lay. From this point on, the gunner must maintain the appropriate rate of track and he must become increasingly consistent in maintenance of the rate. This is a finer

degree of tracking consistency than that which is required in the first segment. The time period for which this smooth tracking must be maintained depends upon the distance to the target. The allowable fluctuations in this tracking depend upon the visual angle to the target, i.e., apparent target size which becomes smaller with increasing target distance. Thus as we increase target range we also



increase the requirement for fine tracking skill and for this consistency over long time periods.

With respect to this study, one could expect gunner performance on the short range targets, during either firing or training, to indicate the gross proficiency level required in the first segment of the task. Beyond this requirement, performance on the long range targets, during firing and training, would indicate proficiency in fine tracking.

2. When gunner proficiency is at a fairly high level, as at the conclusion of the study training program, the introduction of obscuration and missile flare effects does not <u>significantly</u> degrade missile firing accuracy. This is based on the results

of the short-medium range missile and COFT test firings during which these effects are assumed to be most relevant. However, these results do indicate a small but consistent decrease in such performance which might be attributable to introduction of these effects. Considering the supply and cost of actual missiles, simulation of these effects during training might still be justified.

3. High levels of gunnery proficiency achieved during training using short-medium range targets does not transfer to long range targets unless the additional requirements for long range targets, assumed to be fine tracking, are stressed during training. The error record, here the chart recorder, seems to provide assistance in meeting these requirements. This is based on the results of the long range missile firings and in-training COFT tests.

4. The error readings from the chart recorder also seem to provide feedback that greatly increases the rate of proficiency gain during training, thereby significantly decreasing the amount of training time required to attain any stated level of proficiency.

5. Since the miss-distance indicator includes system error plus gunner tracking error, the compounded information may be misleading to the instructor. This would account for the poor performance of Condition II trainees who had only this feedback. If this information is necessary to the development of gunner confidence in the system, it should be introduced with the supplementation of an accurate tracking error record or during the final stages of training, as transition to the missile firing situation.

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APPENDICES

APPENDIX A

Draft Plan for Study of the Training Effectiveness of Components of the Conduct of Fire Trainer XM35.

Assumptions

1. That the functions of the CFT are: (a) to provide special visual effects that will be encountered by the gunner when firing the missile, e.g., missile flare and obscuration, and (b) to provide a permanent continuous record of gunner performance during the missile flight for in flight and post-flight gunner critique, and (c) to provide accurate target range information for missile flight time and hit-miss feedback.

2. That the CFT provides each of these functions through the use of separable components, i.e., visual effects by the scope and visual effects simulator, continuous record by one target bulb and chart recorder, and target range by the two target bulbs.

3. That utilization will consist of approximately 15-30 minutes of simulated range firing practice per trainee during AIT, Armor and further acquisition and retention practice as programmed during BUT and AUT.

4. That presently programmed service tests (US Army Armor Board and US Army Armor School) will adequately determine the training effectiveness of the complete CFT system.

5. That if effective (4 above), training efficiency might be further enhanced if some functions of the CFT were accomplished, at less cost and complexity. And that such simplification might be possible without a corresponding reduction in training effectiveness.

6. That the telescope and visual effects simulator may be considered to be in its simplest form at present and necessary for training. But that the functions of the recording system might be effectively accomplished by a boresighted telescope for instructor monitoring and the function of the target range equipment by an estimated range fed through a timer by the instructor.

Method

Generally the study will consist of three groups of trainees receiving simulated range firing practice using various components of the CFT. Group I will receive practice using the complete CFT system; Group II using the visual effects, recorder, and range timer; and Group III using the visual effects, range timer, and monitor telescope.

Trainees will be randomly selected from AIT trainees who have completed gunnery training but have not fired the gunnery tables. This corresponds to plans for integrating Sheridan-Shillelagh training into the present AIT program.

Each trainee will receive 4 hours of simulated range firing practice. Target range conditions will be specified by CDC, Armor Agency. Training will be given to a minimum of three trainees per period to balance training conditions with peculiar range and target conditions. Approximately 20 trainees will constitute each group.

The performance criteria will be tracking consistency and hit-miss as provided by the complete CFT system. Performance will be measured at the completion of each 1/2 hour of practice. Tests will involve the minimum number of trials required to obtain a reliable measure without providing significant proficiency increases. No feedback to the trainees will be provided. The chart records will be used for analysis.

Conduct-of-Fire Trainer Evaluation Plan

Systems	Veh. Only	CFT-Recorder	CFT (FS)
Students	20 AIT Grad	20 AIT Grad	20 AIT Grad
Orientation Film	Yes	Yes	Yes
Trainer Time	4 Hrs	4 Hrs	4 Hrs
Feedback	TC	TC	Recorder
Criterion	Hits	Hits	Hits
Training Evaluation	Every 30 Min of Training	Every 30 Min of Training	Every 30 Min of Training
Test	Best 6 Fire Two Missiles	Best 6 Fire Two Missiles	Best 6 Fire Two Missiles
Alternate Test	Three Target Passes on CFT	Three Target Passes on CFT	Three Target Passes on CFT

Proposed Responsibilities and Schedule

TARMS	Provide CF Trainers Procure Ranges and Set-up Targets Supervise Training Prepare Report of Test
Armor and Eng. Bd.	Modify Trainers, as Required Provide Missiles (36) Supervise Firing
HumRRO	Procure and Pretest Students (TARMC) Assist in Training Analyze Results
CDC, Armor Agency	Monitor Training Monitor Testing
Schedule	Train and Test Ten Students for Each Group for 1-14 February Train and Test Ten Students for Each Group for 15-28 February Final Report 14 March

APPENDIX B

NEWMAN-KEULS ANALYSES WITHIN CONDITIONS AND WITHIN DAYS FOR IN-TRAINING PERCENTAGES

TABLE 7

Newman-Keuls Analyses Within Conditions During Replication 1 Training

Condition I

Training Day and Average

	2	3	4	5	6
	37.50	43.75	56.25	68.75	100.00
2		6.25	18.75*	31.25**	62.50**
3			12.50	25.00**	56.25**
4				12.50	43.75**
5					31.25**

Condition II

Training Day and Average

	3	4	2	5	6
	30.56	50.00	58.33	66.67	83.33
3		19.44**	27.77**	36.11**	52.77**
4			8.33	16.68*	33.33**
2				8.34	25.00**
5					16.66*

Condition III

Training Day and Average

	2	5	3	4	6
	72.50	75.00	80.00	87.50	100.00
2		2.50	7.50	15.00	27.50**
5			5.00	12.50	25.00**
3				7.50	20.00**
4					12.50*

* designates $p < .05$
** designates $p < .01$
for all tables

TABLE 8

Newman-Keuls Analyses Within Conditions During Replication 2 Training

Condition I

Training Day and Average

	3	1	4	5	6	2
	13.89	30.56	30.56	72.22	77.78	88.89
3		16.67*	16.67*	58.33**	63.89**	75.00**
1			0	41.66**	47.22**	58.33**
4				41.66**	47.22**	58.33**
5					5.56	16.67**
6						11.11

Condition II

Training Day and Average

	1	4	3	6	2	5
	15.62	37.50	50.00	90.62	93.75	93.75
1		21.88**	34.38**	75.00**	78.13**	78.13**
4			12.50	53.12**	56.25**	56.25**
3				40.62**	43.75**	43.75**
6					3.13	3.13
2						0

Condition III

Training Day and Average

	1	3	2	5	4	6
	56.25	59.38	62.50	65.62	68.75	90.62
1		3.13	6.25	9.37	12.50	34.37**
3			3.12	6.24	9.37	31.24**
2				3.12	6.25	28.12**
5					3.13	25.00**
4						21.87*

TABLE 9

Newman-Keuls Analyses Within Days During Replication 1 Training

Day II

Training Condition and Average

	1	2	3
	37.50	58.33	72.50
1		20.83	35.00*
2			14.17

Day III

Training Condition and Average

	2	1	3
	30.56	43.75	80.00
2		13.19	49.44**
1			36.25**

Day IV

Training Condition and Average

	2	1	3
	50.00	56.25	87.50
2		6.25	37.50**
1			31.25**

Day V

Training Condition and Average

Nothing Significant

Day VI

Training Condition and Average

	2	1	3
	66.67	100.00	100.00
2		33.33**	33.33**
1			0

TABLE 10

Newman-Keuls Analyses Within Days During Replication 2 Training

Day I

Training Condition and Average

	2	1	3
	15.62	30.56	56.25
2		14.94	40.63*
1			25.69

Day II

Training Condition and Average

	3	1	2
	62.50	88.89	93.75
3		26.39*	31.25*
1			4.86

Day III

Training Condition and Average

	1	2	3
	13.89	50.00	59.38
1		36.11**	45.49**
2			9.38

Day IV

Training Condition and Average

	1	2	3
	30.56	37.50	68.75
1		6.94	38.19*
2			31.25

Day V

Training Condition and Average

Nothing Significant

Day VI

Training Condition and Average

Nothing Significant